US CMS Cost, Schedule, & Management Summary

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US CMS
Construction Project Manager

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Outline

Cost Estimate

Schedule

Funding & Obligation Profiles

Organization and Management

Cost Estimate

Process of Development

- **Bottoms Up Estimate of Lehman I Scope**
  - Modest Increase of 4.6% in base estimate
    - **Real Increases**
    - **Manpower assumed from "base program"**
    - **Overheads (hadn't been) properly included**
- **Project Management Review Team and special consultants were presented each of the Detector SubSystems in a 1 or 2 day Review**
  - Input by Reviewers received on both validity of "base estimate" and adequacy of L2 Manager suggested contingency

Cost Estimate

Process of Development (continued)

- **Apply Adequate Contingency**
  - Extensive Interaction between/among the PMG, TD and PM (L1), and L2 Managers
  - New Base Estimate for Lehman I Scope plus adequate contingency required about an 17% “rescoping” to achieve a cost reduction that fits within available resources
- **TD suggested rescope actions to meet these targets**
  - another round of PMG Meetings were held to review the new “bottoms up” estimates for the descoped subdetectors and guide L2 rescoping progress
- **Iterated with International CMS Management**

Cost Estimate

WBS Number	Description	EDIA (k$)	M&S (k$)	Mfg Labor (k$)	Base Cost (k$)	Cont (k$)	Cont (%)	Total Cost (k$)	DOE Request (k$)	NSF Request (k$)
US CMS Total Project Cost (then-year dollars)								**167,245**	**147,046**	**20,199**
Escalation (DOE January 1998 indices)								14,485	12,803	1,682
FY97 R&D								4,640	4,640	
FY96 R&D (FY97 dollars)								2,364	2,364	
US CMS Total Estimated Cost (FY97 dollars)		**19,204**	**73,006**	**9,767**	**101,976**	**43,779**	**43**	**145,756**	**127,239**	**18,517**
1	Endcap Muon	4,744	14,605	4,840	24,190	10,955	45	35,145	34,213	932
2	Hadron Calorimeter	3,978	19,540	4,106	27,624	12,954	47	40,578	35,721	4,857
3	Trigger and Data Acquisition	3,454	7,461		10,915	5,712	52	16,627	15,680	947
4	Electromagnetic Calorimeter	1,651	5,502		7,153	3,579	50	10,732	7,589	3,142
5	Forward Pixels	645	3,211	820	4,677	3,028	65	7,704	3,092	4,612
6	Common Projects		22,249		22,249	5,522	25	27,770	24,404	3,366
7	Project Office	4,733	438		5,170	2,030	39	7,200	6,539	661

Contingency Analysis

Contingency = (Design Maturity) * (Judgment Factor)

Design Maturity

DM = 1.5: There is only a conceptual design.
DM = 1.4: There is a RFI or request for vendor information, with engineering sketches.
DM = 1.3: There is a TDR with an engineering design.
DM = 1.2: There is a bid package ready to go out, or a quote.
DM = 1.1: The bid is awarded, or a purchase order is written, or the item is from a catalogue.
DM = 1.0: The item is invoiced/completed.

Contingency Analysis

Judgement Factor

The range for the judgment factor might typically go from 1.0 to 1.4.

The technical risk is crucial.

The schedule risk is important.

Are there manufacturing difficulties.

Omissions must be covered.

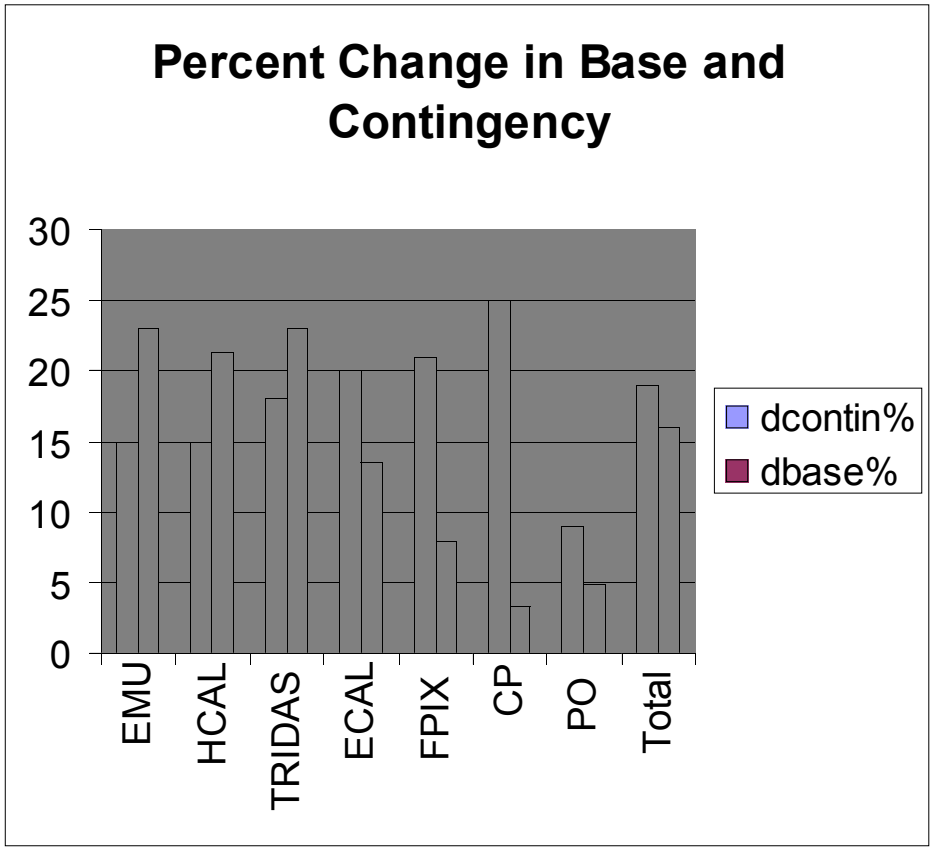
Possible additional Escalation.

Commodity Fluctuations.

Currency Fluctuations.

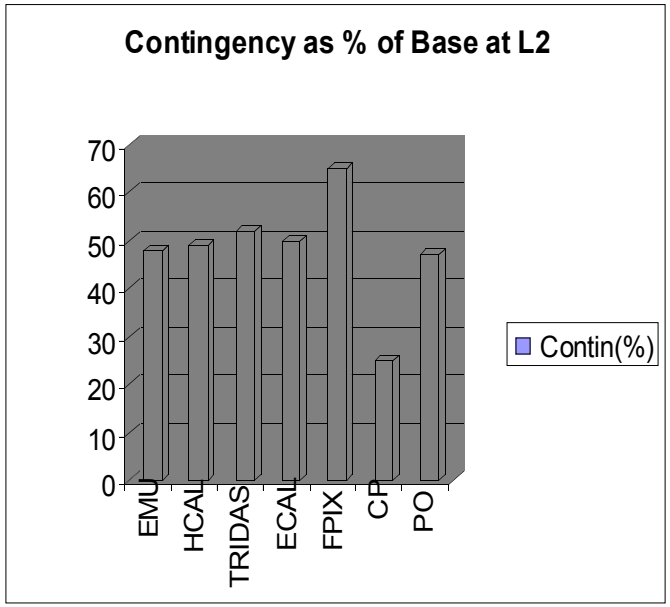
Cost Estimate - Rescoping

- The contingency for the total project is now 43% (49% for the detector subsystems), increased by 18% w.r.t. LEHMAN I
- The base cost is reduced by 17% maintaining a fixed total cost.



Cost Estimate - Contingency

The TD and CP believe that US CMS now has a contingency level consistent with recent HEP experience. And that this is appropriate for the US CMS detector!!



Cost Estimate

Change Control

- **Change Control Boards (CCB)**
  - Act at pre-determined thresholds: Positive / Negative cost control changes increment / decrement contingency.
    - **JOG if TEC changes**
    - **Agency Project Manager -- 10%@ WBS L2 or cum $2.5**
    - **Fermilab Deputy Director -- 10%@WBS L3 or cum$1.0M**
      - With advice from the PMG as a CCB
    - **L1 Managers -- Any change in Cost at WBS L3**
    - **L2 Managers -- $100K Changes w/i L3 to cum $500; contingency applications of $10ea cum $100K**

Cost Experience

HCAL: The bid for the Cu absorber was awarded to Felguera (Spain) for 7.7 M$ with an estimated cost before bids of 9.3 M$. This is down by 21% and is ~ 1/4 of the total base cost of HCAL.

EMU: The M&S costs for the chambers are a major cost driver. Purchases of panel material (FR4) in FY98 are 23% less than the WBS cost estimate. Additional funds, if available, will be used to "lock in" this price with the sole available vendor.

Resource Loaded Schedule

- The “schedule” comprises about 5000 tasks and about 2000 resources. Significant supporting documentation.
- EDIA and Labor are in the resource sheet.
- WBS dictionary is in the notes field of the file.
- Contingency is defined at lowest level of the WBS, usually L7 using design maturity and judgment.
- Resource and commitment profiles are derived from the resource loaded schedule.

Resource Loaded Schedule

- J. Hanlon and D. Green Developed Microsoft (MS) Project Templates which L2 Managers used to fill out the detailed cost & schedule information for their subdetector
- US CMS held a L2 Project Management Work Shop at Fermilab where CDF and DØ cost / schedule experts shared their experience

Resource Loaded Schedule

ITERATED SEVERAL TIMES WHILE

- Getting Scope / Cost / Contingency "set" and
- Getting Schedule / Obligations Profile Consistent with the Funding Profile

CMS Work Plan

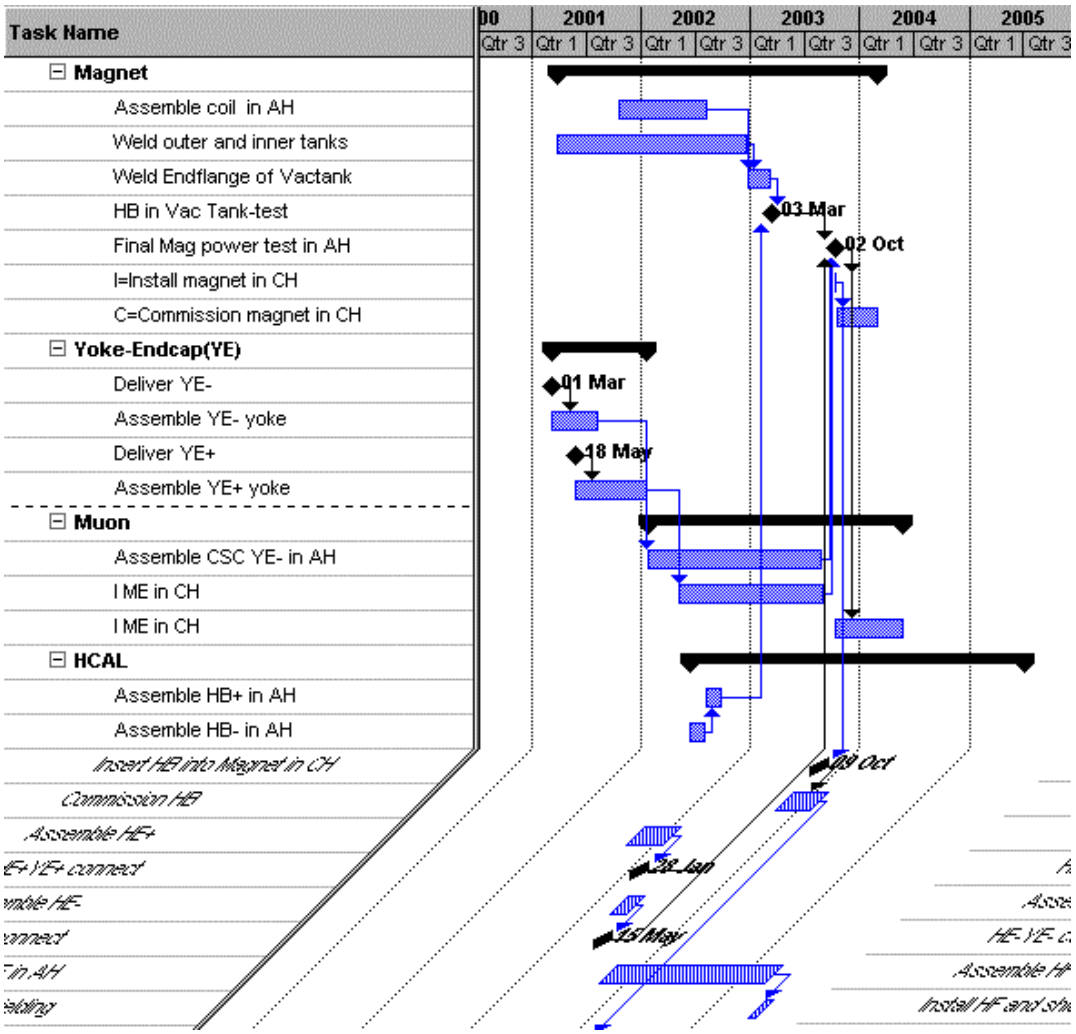
Int'l CMS Completes in 2005

CMS Construction Schedule

ID	Task Name	Start	Finish
1	Civil Engineering	23/1/98	31/12/02
2	Design of buildings	23/1/98	9/7/98
3	Fabrication of buildings	10/7/98	7/6/01
4	Surface hall SX, first phase ready	3/1/00	3/1/00
5	Underground	1/10/98	31/12/02
6	first phase	1/10/98	13/6/00
7	second phase	3/1/00	27/9/02
8	hall ready	31/12/02	31/12/02
9	Magnet	23/1/98	30/6/04
10	Design and prototyping	23/1/98	16/4/98
11	Construction	17/4/98	22/6/00
12	Assembly	23/6/00	6/6/03
13	Test	6/6/03	28/8/03
14	Installation	29/8/03	30/6/04
15	Muon System	23/1/98	30/6/04
16	Design and prototyping	23/1/98	16/4/98
17	Preproduction	17/4/98	10/6/99
18	Procurement and production	13/7/99	30/12/03
19	Installation	1/6/01	30/6/04
20	HCAL	23/1/98	30/6/05
21	Preproduction	23/1/98	31/12/98
22	Procurement and production	1/1/99	31/12/03
23	Installation HB/HE	1/3/03	6/3/04
24	Installation HF	1/3/05	30/6/05
25	ECAL	23/1/98	31/3/05
26	Design and prototyping	23/1/98	31/3/98
27	Preproduction	1/4/98	31/12/98
28	Procurement and production	1/1/99	31/3/04
29	Installation	1/4/04	31/3/05
30	Central Tracking System	23/1/98	30/6/05
31	Design and prototyping	23/1/98	30/9/98
32	Preproduction	1/10/98	31/12/99
33	Procurement and production	3/1/00	30/6/04
34	Installation	1/7/04	30/6/05

27 April 1998

Scheduling Evolution - US CMS L1 Schedule



Because the coil is now wound in industry, the assembly hall schedule has loosened up

The HB and HE schedule start has been delayed by about 1 year

The YE schedule has been delayed by about 9 months.

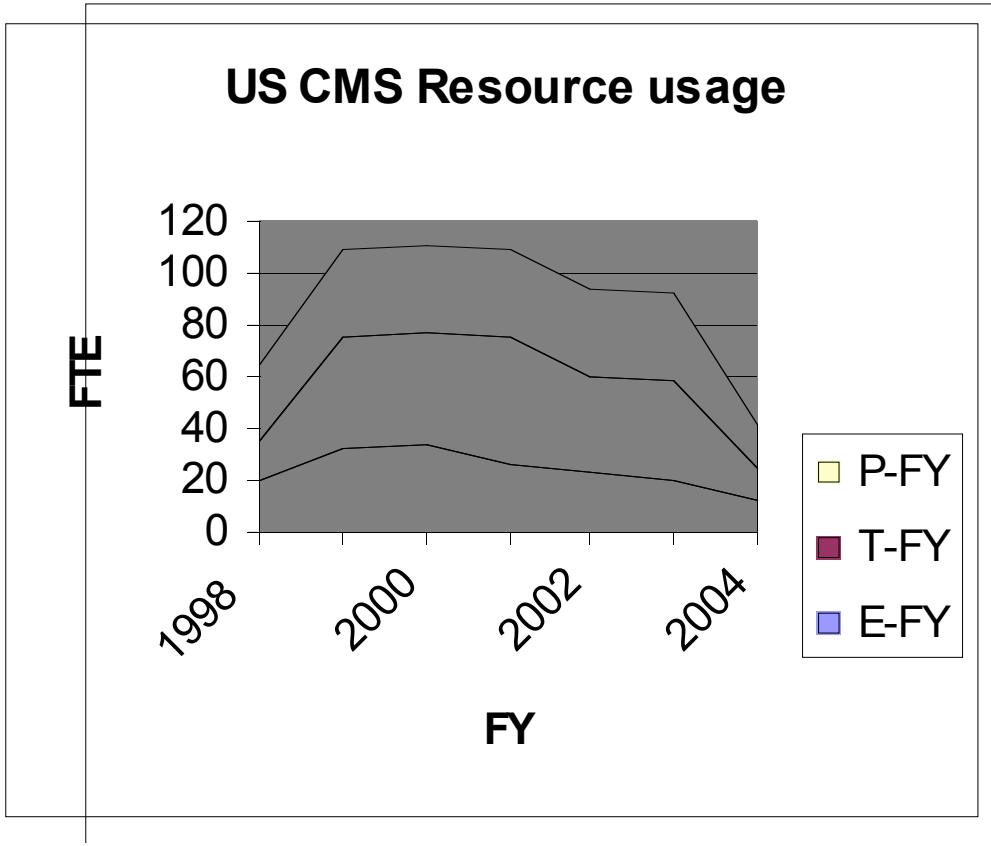
Schedule Change Control

- **Change Control Boards**
  - Act at pre-determined thresholds

• JOG if TEC changes	7 Milestones
• Agency Project Manager	20 Milestones
• Fermilab Deputy Director	20 Milestones
• L1 Managers	100 Milestones
• L2 Managers	n00 Milestones

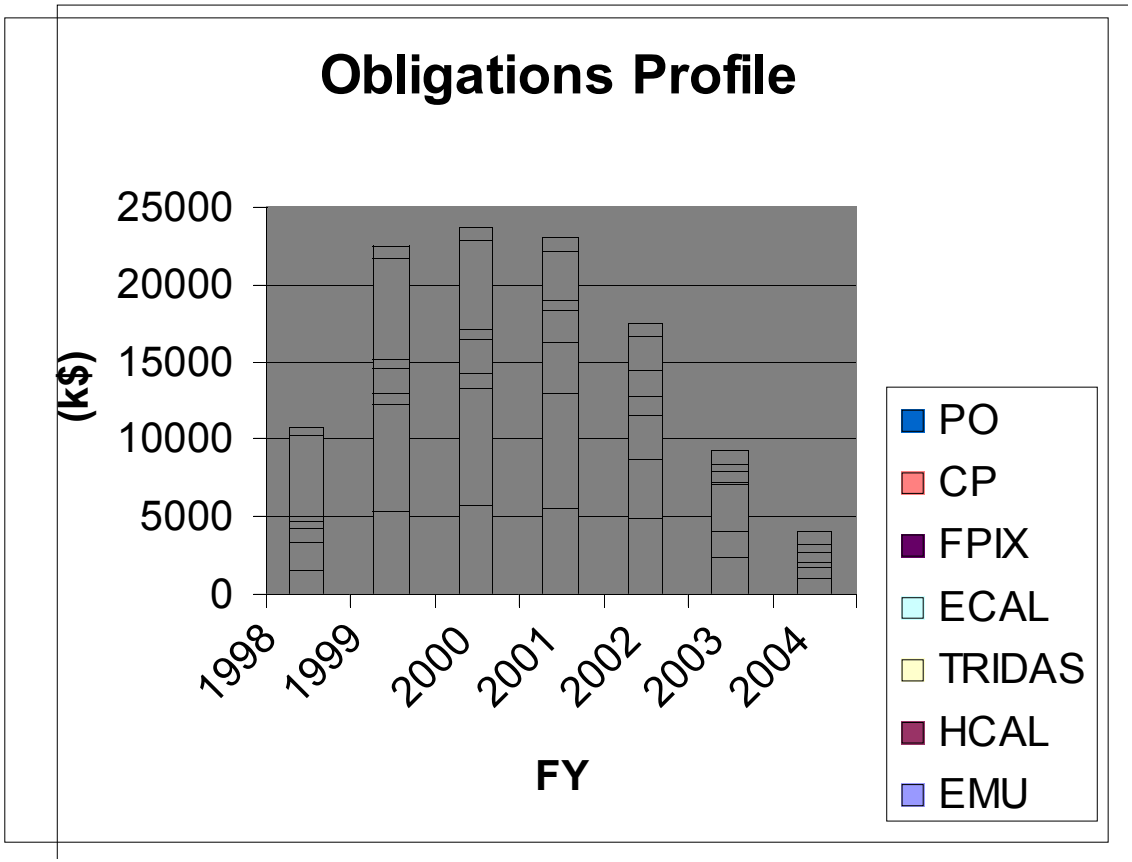
Resource Usage

The resource usage is derived from the resource loaded schedule. Engineers, technicians and physicists can be distinguished and tracked separately.



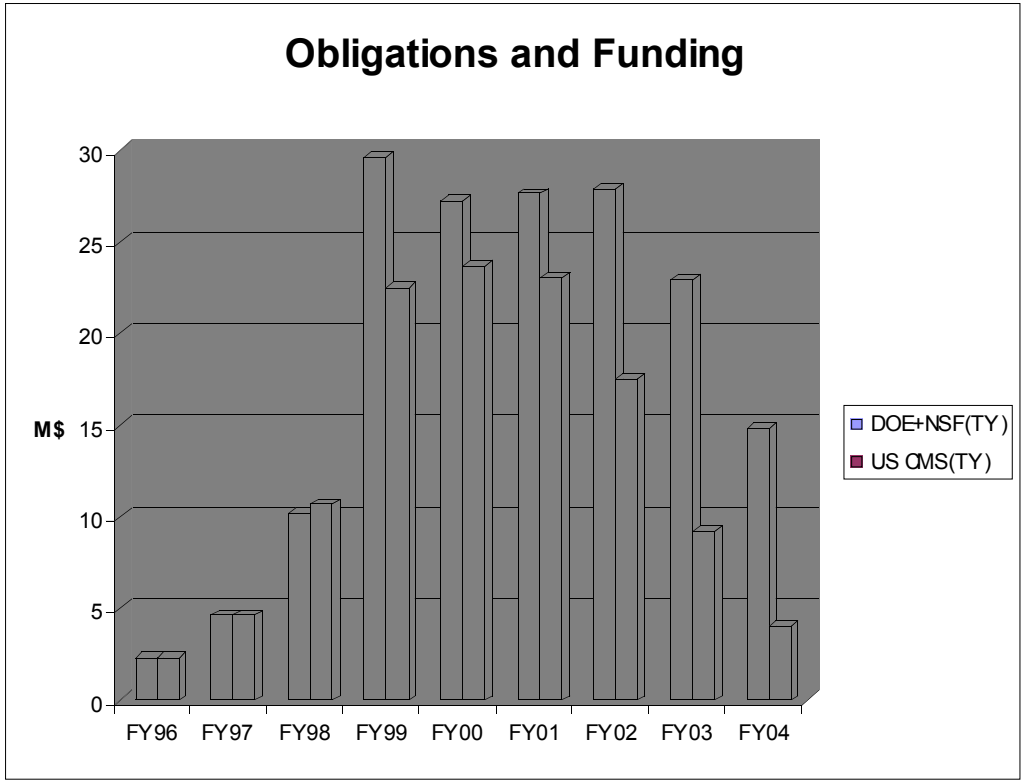
Obligations Profile

Each of the L2 managers have worked with the PO to "soften" the profile.



Commitments and Funding Profiles

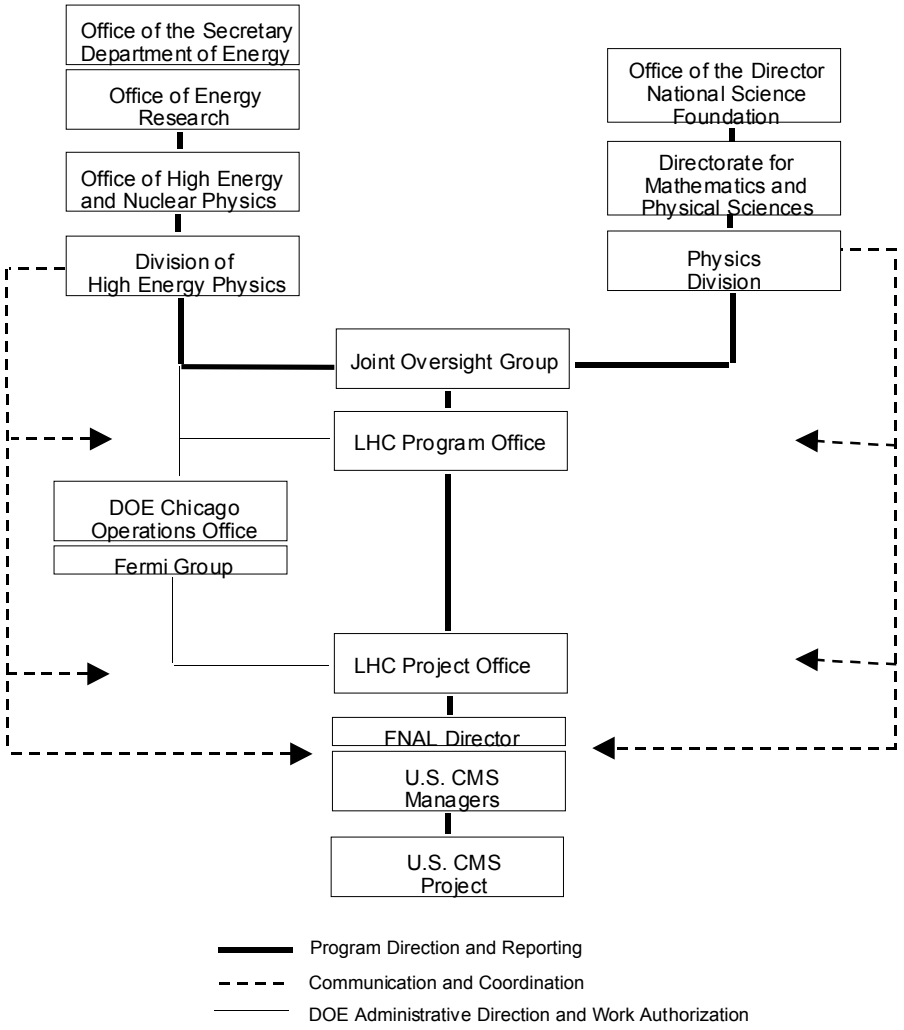
The "softer" profile falls within the given funding profile. The PO's goal is to manage CMS work activities to maximize the effectiveness of available funds.



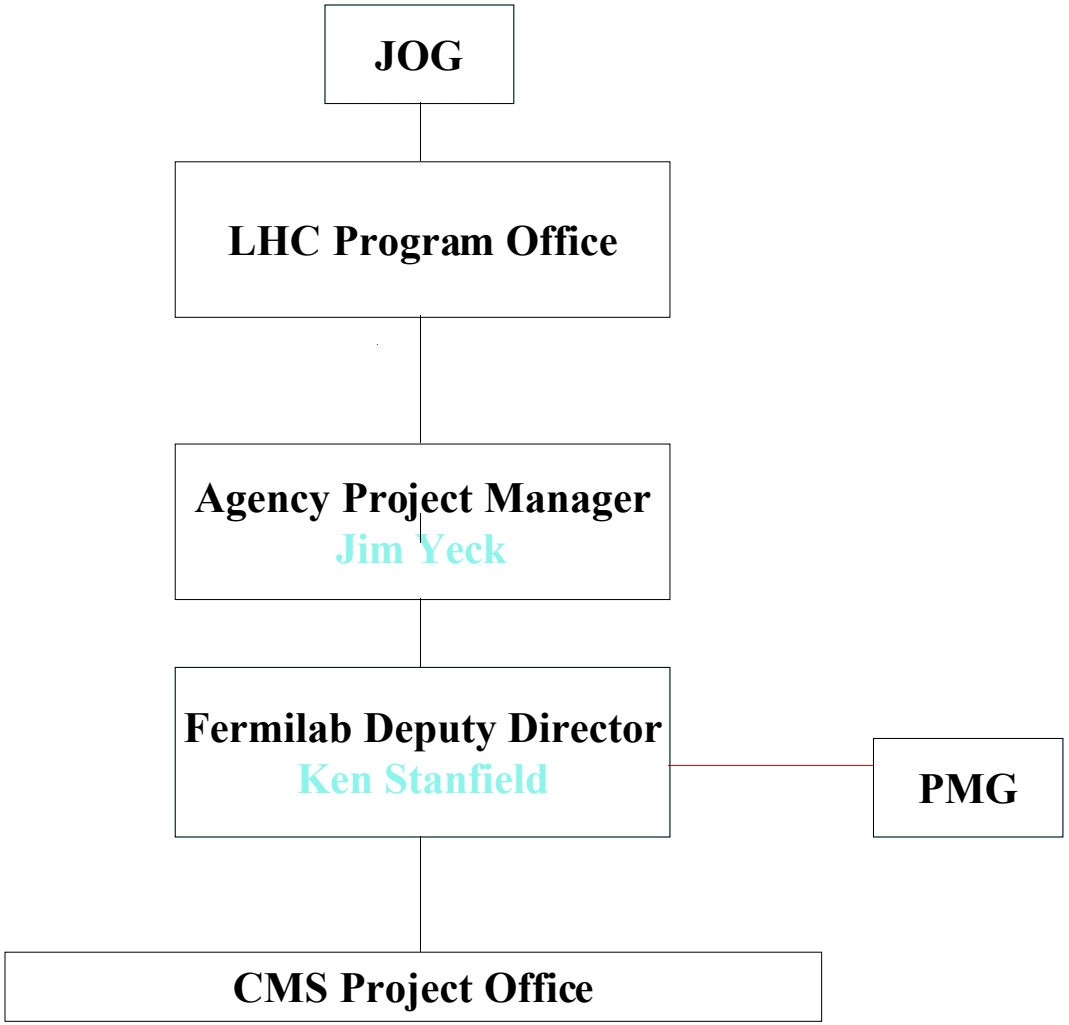
Procurement Plan - FY99

- We've provided for a possible large contingency utilization in FY99.
- Should that prove unnecessary, US CMS has a plan to advance the schedule.
  - Buy CP steel faster - dollar is strong now
  - Buy Cu HCAL absorber faster - copper is at an all time low price now
  - Buy more EMU M&S - FR4 is ~ 23% below the quoted WBS price just now and G.E. is a sole source. This reduces both costs and risks.

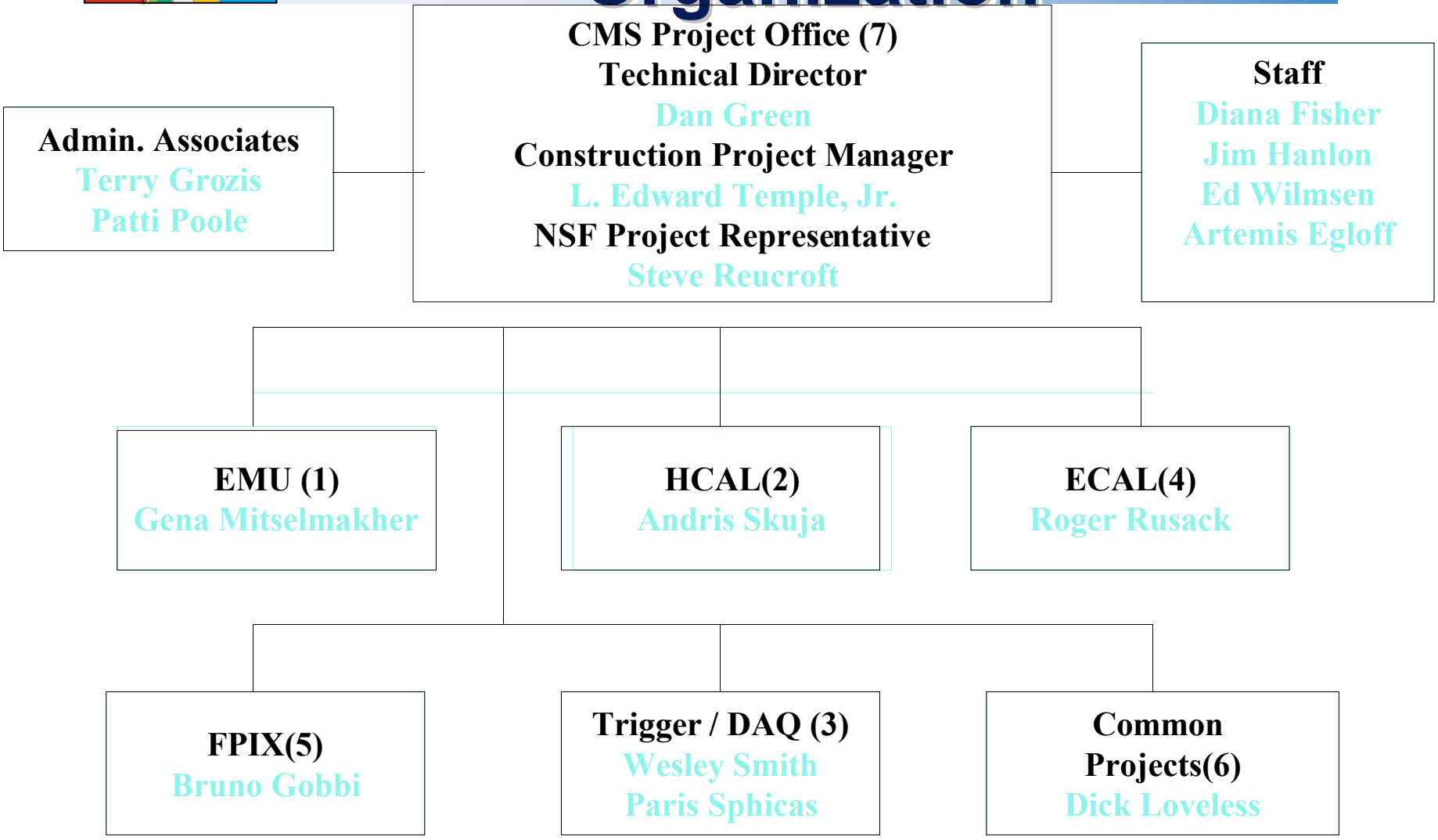
US CMS Project Organization



US CMS PROJECT MANAGEMENT ORGANIZATION



US CMS Project Organization



L2 Manager's RRAs

- Planning and managing the design, construction, installation, and commissioning of their respective subdetector (/subsystem) projects
- Providing guidance to all L3, L4 and other personnel working on their subsystem
- Serving as the cost/schedule manager for all WBS elements in their subprojects
- Participating in project planning and scheduling
- Managing cost estimating for their subsystem
- Participating in accessing work accomplishments and developing corrective action or "work around" as needed to stay on schedule and within cost

Mgmnt Mtgs, Reviews

Weekly Meetings with Agency PM

Weekly US CMS PO Staff Meetings

Weekly L1 / L2 Televideo Meetings

Monthly L1 Progress Meetings planned with each L2 Manager

- **Will cover Technical Progress**
- **and Cost and Schedule Status / Progress**
- **as well as Administrative Status / Progress**
  - MOUs, SOWs, R&D subcontracts, Invoicing

Design Reviews as Designs Evolve

Mgmnt - Mtgs etc (cont)

- There are regular meetings of the Fermilab PMG.
- The L2 managers have meetings with their L3 managers and the subsystem groups.
- We have had a “MS Project” workshop with CDF and D0 advising the L1 and L2 managers. We plan a similar “Cost and Schedule” workshop after we are baselined.
- There is a weekly teleconference (focusing on reporting) of the CMS TB, MB, or SC. There are other video meetings with CMS-CERN which occur regularly.
- There are quarterly “CMS Weeks”.
- The PO maintains critical documents and instructions on the US CMS server. For example, template instructions.

Mgmnt - Business Sequences

Purchasing

- Release of Long Term R&D Subcontracts
- Issuance of Purchase Requisitions (PR) and then Purchase Orders (PO) pursuant thereto

Budget

- Funding for US CMS controlled by FNAL Budget Office at Budget & Reporting Code level

Accounting

- Invoices for US CMS expenditures go into FNAL General Ledger after approval by PO

Similar processes to be implemented at Northeastern for NSF funded activities

Management Thresholds

- Most of the SOW are signed (39 of 44 active in FY98). The PR are being generated. And in cases of grants, the signed SOW funding levels are communicated to DOE.
- L2 managers must agree to any purchase above 10k$.
- Purchases over 100 k$ must be agreed to by the PM. (This has been exercised twice already in HCAL)
- For large purchases the intent of the Project Office is to hold issuance of the PO until the results of a solicitation process are known. An example is the U. of Wisconsin endcap FY98 payment of ~ 2 M$.
- Once the bugs are worked out and proper adjustments are made, this procedure should not result in undue delays. The 2.7 M$ for barrel vacuum tank FY98 contribution was successfully committed.

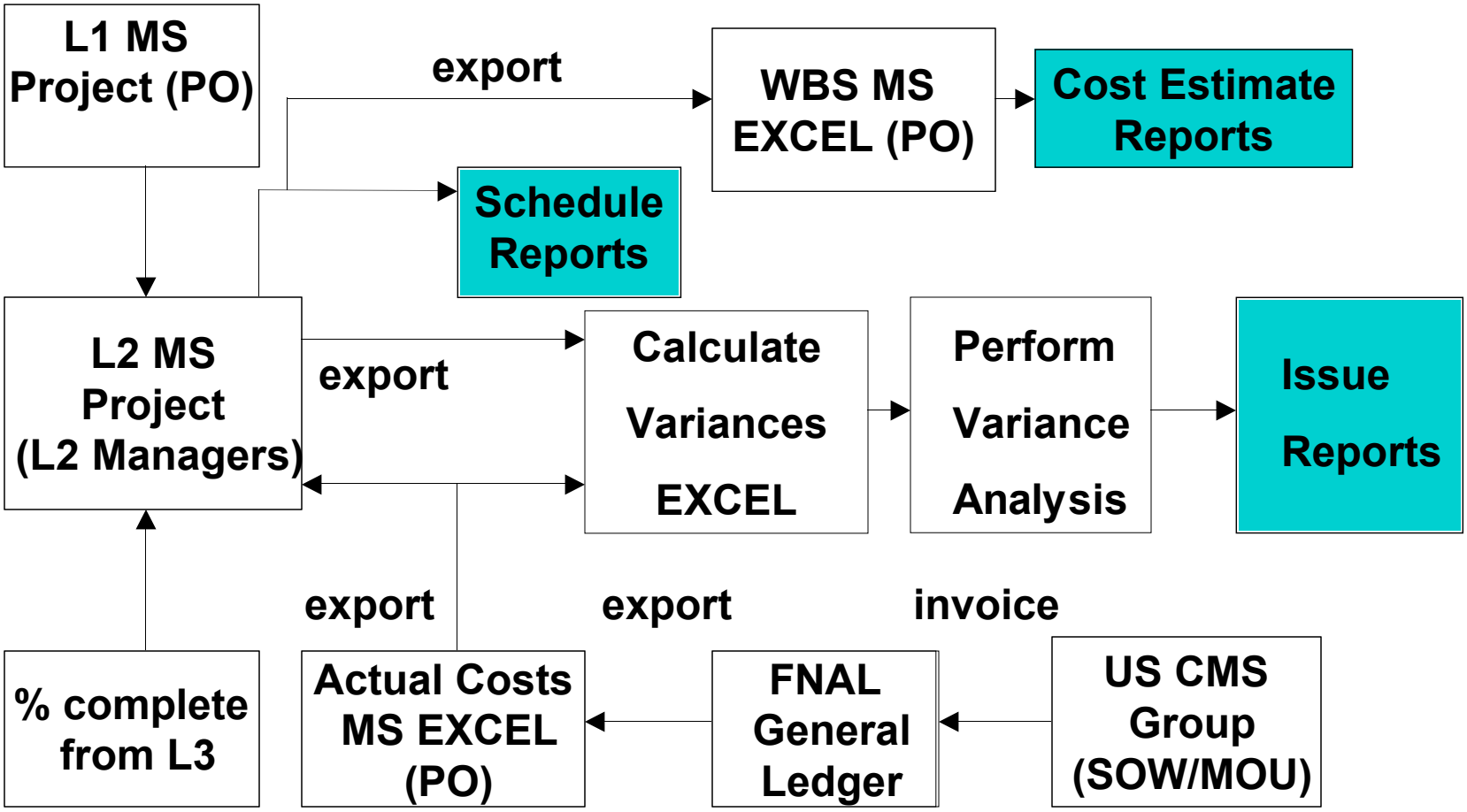
Mgmnt -- C/SCS

Cost and Schedule Control System

- Utilizes Resource Loaded Schedules in MS Project at the lowest level of the WBS (BCWS)
- L2 Managers provide monthly per cent complete updates for current activities, this gives the "earned value" (BCWP)
- "Lookup table" provides (from 1 to 1 budget code correspondence to WBS at lowest level) actual costs (ACWP) from invoices submitted
- Cost and Schedule Variances are calculated and Variance Analyses are created
- Change Requests are created and processed
- Monthly Summary Reports are provided to the Agency PM and L2 Managers as appropriate

Project Management Tools, Processes, & Reports

A system using MS Project, MS Excel is in place or under development.



Project Office

The PO has been fully staffed in FY98.

A recent addition is WBS 7.6, Educational Support

Upcoming Activities

Complete issuance of FY98 PO

Get Project Management Plan approved

Get MOU developed and signed

Issue long term R&D subcontracts

Implement Performance Measurement

Develop SOW for FY99

Summary and Conclusions

- The committee concerns about management have been addressed.
- A fully resource loaded schedule and estimated cost has been produced.
- The contingency is consistent with recent HEP experience - 43% (50% CTC).